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A Morphologic Comparison of the Normal Dentitions of Adult Caucasian Males and Adult Negro Males

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A MORPHOLOGIC COMPARISON OF THE NORMAL DENTITIONS OF ADULT CAUCASIAN MALES AND ADULT NEGRO MALES

by

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ABOUT THE AUTHOR

David A. Binotti was born in Chicago, Illinois, in April, 1943.

He obtained his primary education in Oak Lawn, Illinois, and attended Brother Rice High School in Chicago, Illinois, where he received his diploma, with honors, in June, 1961.

He then began his predental education at Loyola University, Chicago, Illinois, under a Chicago area high school tuition scholarship.

After two years of predental work, he entered Loyola University School of Dentistry in Chicago. In 1967, he received his D.D.S. degree and began graduate studies in oral biology in the orthodontic department of Loyola University.

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CHAPTER I

INTRODUCTION AND STATEMENT OF THE PROBLEM

A. Introduction:

Dr. Angle defined normal occlusion in the following manner: "Occlusion is the normal relations of the occlusal inclined planes of the teeth when the jaws are closed." He went on to say, "The normal denture in its completeness includes not only the jaws, alveolar process, dental arches, and especially, the roots and periodontal membrane, but also the muscles of the lips, cheeks, tongue and mouth, the nasal passages, palate and throat, as these assist in performing their functions and are also powerful factors in establishing and maintaining either harmony or inharmony of development and arrangement of the teeth, and this just in proportion as they are singly, collectively, normal or abnormal in their own development and function."

Because of the varied physical attributes existing among various ethnic groups, as pointed out in anthropological studies, such as muscle attachments, lip posture and tonus, cranio-facial dimensions, these influencing factors described by Angle vary in the amount of effects produced in the dentitions of the individuals of differing racial characteristics. Therefore, what is acceptable normal form and occlusion for one may not be true for another.

This thesis is concerned with the specific similarities and variations between the acceptable normal occlusions of young Caucasian adult males and young Negro adult males.

B. Statement of the Problem:

To assess, using orthodontic diagnostic casts, the similarities and variations in the normal dentitions of the adult Caucasian male and adult Negro male and to evaluate these factors statistically.

CHAPTER II

REVIEW OF THE LITERATURE

Of the early diagnostic aids used by practitioners in orthodontics, the plaster cast recorded permanently the arrangement of the teeth and surrounding structures. The value of an accurate set of articulated casts was stressed by Angle in 1895. From Angle's time to the present, practitioners and research men alike have been able to derive valuable information from plaster casts. The data in this review is derived essentially from plaster casts.

Many studies of tooth disharmonies have been made on plaster casts. So too, various systems of diagnoses have been devised based on measurements taken from plaster records. Hawley (1905) suggested a method of predetermining arch form from casts of malocclusions. The Hawley Index is based on the Bonwill principle of the standard arch. By placing a celluloid chart over the cast, one could supposedly see at a glance the deviation present from the ideal arch form described on the chart.

Pont (1909) formulated the theory that wide or broad teeth require a broad arch and narrow teeth require a less wide arch. Measurements were made of casts of many arches showing no crowding of teeth. The width of the maxillary four incisors was correlated with the first inter-premolar and first intermolar arch widths. From these measurements

and correlations, Pont provided a table of arch widths based on tooth widths. Thus by the use of Pont's Normal Tooth Index, the approximate amount of change required in the arch could be determined.

Gilpatric (1919) analyzed arches which varied in tooth substance from seventy-eight millimeters to one hundred-one millimeters for the maxillary arch, measuring from buccal groove of one first molar to the buccal groove of the opposite first molar, and the corresponding tooth substance for the lower arch, which he found varied with the upper from eight millimeters to twelve millimeters. From his analysis, he produced a set of charts showing the dimensions of the arches varying between the extremes mentioned. He made twenty-seven celluloid charts, one millimeter difference between charts. By measuring the teeth on the case in question, a chart with the corresponding measurements could be laid over the cast, and deviations from the ideal arch form could readily be noted.

Neff (1949) suspected that everything else being normal, an orthodontic or naturally occurring normal occlusion will settle to the degree of overbite indicated by the "anterior coefficient". He felt that one could predetermine the amount of overbite in a finished case by applying what he termed the "anterior coefficient". He measured the mesiodistal diameters of both maxillary and mandibular anterior teeth on two hundred sets of casts. He then divided the maxillary sum by the mandibular sum and thus derived this coefficient. For an ideal

overbite, the "anterior coefficient" must be 1.20 to 1.27.

Howes (1954) described a multitude of measurements and evaluations which can be derived from dental casts, such as coronal and basal arch widths in the molar and premolar regions, maxillary and mandibular midline basal arch lengths, correlations of basal arch widths in the premolar region with total tooth material. He concluded that in normal dentitions, there is a range of variation of tooth material, coronal and basal arch widths and basal arch length. There is also a range of variation of the interrelationships of these various measurements. He plotted these normal limits on graphs, or polygons, similar to the Vorhese polygonal interpretation of the Downs cephalometric analysis.

Bolton (1958) made a series of measurements on models of fifty-five cases showing excellent occlusions. From these measurements he established certain ratios by which he claimed he could predetermine post-treatment results. The first was a ratio of the sum of the mesiodistal widths of all the teeth from first molar to first molar in the maxillary arch, to the sum of the mesiodistal widths of the same teeth in the mandibular arch. When the twelve maxillary teeth were compared with the twelve mandibular teeth in a ratio as sum mandibular 12/sum maxillary 12 x 100 equals over-all ratio, a statistically significant mean, standard deviation, and coefficient of variation were found to exist. They were 91.2, plus or minus 0.26, 1.91 and 2.09% respectively. The second ratio was of the maxillary six anterior teeth to the mandibular six anterior teeth. The anterior ratio involves the six maxillary

anteriors and six mandibular anteriors as sum mandibular 6/sum maxillary 6 x 100 equals anterior ratio. Equally significant findings were obtained. For a mean of 77.2, plus or minus 0.22, the standard deviation was 1.65 and the coefficient of variation was 21.4%.

In an attempt to make cast analysis more meaningful, some investigators have devised methods of constructing dental casts that are related to various cranial landmarks. All of these systems involve complicated devices and techniques. Simon (1926) termed his analysis "gnathostatics", and the device used was called the gnathostat. Measurements taken on the head, while the impression material and tray were in the mouth, were transferred to this mechanism and the casts were made in relation to these measurements. He felt that it was possible then to employ the casts as an aid in visualizing deviations in three planes of space. This method for cast construction has been employed, with minor refinements, by Dewey (1935), Salzmann (1943), and McCoy and Shepard (1956).

Iyer and Desai (1963) studied plaster casts of one hundred Indian male adults with normal occlusion and pleasing facial appearance. The extent of "acceptable normal" overbite, overjet, slight incisor crowding, spacing, posterior crossbites, rotations, canine occlusion and canine inclination was evaluated and compared with the ideal normal. They concluded that:

1. Nearly two-fifths of the lower incisor was covered by the upper incisor in normal overbite situations. There

was no correlation between overbite and eruptive heights of incisors or molars.

2. Incisor crowding and incisor spacing was noted in nearly all cases.
3. A low percentage of posterior crossbites precludes them from being accepted as normal.
4. Canine inclination to occlusal plane showed that vertical maxillary canines and even distally tipped mandibular canines were within reasonable limits of acceptance.
5. Canine occlusion was cusp-to-cusp in one-half the cases and ideal in the other half.

W. Thomas (1966) studied the normal dental characteristics of the adult Caucasian male in his attempt to set-up a program for a computerization of cast analysis. Among other things, he found that:

1. There is a wide range of acceptable normal variation for each factor considered.
2. Premolar occlusion is less variable than canine and first molar occlusion.
3. Normal axial inclination of maxillary and mandibular canines varies from mesially to distally inclined.
4. In normally occluding dentures, there is no correlation between the width of the anterior teeth and posterior width across the arch.
5. Crowding of mandibular anterior teeth occurs in nearly

all adults. A small amount of arch length discrepancy is considered normal in adults.

6. Tooth measurements were established that accurately describe normal occlusion for a specific race, sex, and age group within the population.

Red (1967) studied the dental characteristics of the North American Negro male with normal occlusions. Fifty sets of plaster casts were examined and evaluated. From his measurements and analyses he concluded:

1. The range of normal variability in tooth size within this group was very great.
2. A significant coefficient of correlation could not be found when the mesiodistal width of the anterior teeth was related to the posterior width across the arch.
3. The mean sizes of the teeth are definitely larger for North American Negro children than for North American Caucasian children.
4. The maxillary and mandibular units can be divided so as to give normal ratios which can be compared with one another.
5. Variation from ideal were found in the entire sample.
6. Overbite within the range of 1.0 mm, to 4.0 mm should be considered normal.

7. Anterior overjet within the range of 1.0 mm to 5.0 mm should be considered normal.
8. The depth of the curve of Spee should not exceed 2.5 mm at its deepest point in normally occluding teeth.
9. A small amount of arch length discrepancy should be considered normal.
10. A significant coefficient of correlation could not be found when the degree of overbite was related to the anterior ratio.

CHAPTER III

MATERIALS AND METHODS

A. Selection and Characteristics of the Sample:

The orthodontic diagnostic casts used in this investigation were of thirty-one male Negro young adults having normal occlusions and fifty male Caucasian young adults having normal occlusions.

The sample of young Negro adult males was part of a group of approximately two thousand North American Negro boys examined by Red (1967) and R. Thomas (1967) in five youth centers. The examination was intraoral and extraoral. The average age of the sample was sixteen years. From this group, thirty-one individuals were chosen meeting the following criteria:

1. Presence of all teeth (third molars not considered)
2. No previous orthodontic treatment
3. Normal gingival condition and good oral hygiene
4. Symmetry of maxillary and mandibular arches
5. Class I molar relation (Angle) on both right and left sides
6. Absence of temporomandibular joint disturbance
7. Broken contacts causing no more than five millimeters of crowding in the maxillary or mandibular arch
8. Curve of Spee not in excess of three millimeters on either side

9. Anterior overjet not in excess of five millimeters
10. Anterior overbite not in excess of five millimeters
11. Spacing not in excess of five millimeters in either arch
12. No teeth rotated over twenty degrees

The sample of young Caucasian adult males was obtained from five hundred university students who were examined intraorally and extraorally. From this group, fifty individuals were selected meeting the same criteria specified for the sample of young Negro adult males. The average age of the subjects in this group was twenty-five years, six months.

Each subject was given a number which was subsequently used to identify his records. This provided an easy method for labeling and identifying the records and prevented a prejudiced appraisal of the findings which might have resulted had the subject's name been used.

B. Methods of Obtaining Records:

Maxillary and mandibular impressions were taken on each subject of the Negro sample using alginate impression material. Proper fitting trays were selected for each subject. These were beaded with Mortite to insure adequately "deep" impressions incorporating the alveolar process and its soft tissue covering. The impressions were poured immediately with Kerr Snow-white plaster #1. The plaster casts were trimmed so that the top and bottom were parallel, and all sides perpendicular, to the mandibular occlusal plane. Thirty-one sets of casts were

trimmed in this manner, and finished.

Maxillary and mandibular impressions were taken on each of the fifty students in the manner previously described. The impressions were poured immediately with Kerr Snow-white plaster #1. The models were trimmed so that the top and bottom were parallel, and all sides perpendicular, to the mandibular occlusal plane. Fifty sets of casts were trimmed in this manner, and finished.

C. Linear Relationships to be Used:

The plaster casts of both samples will be analyzed to facilitate an understanding of the similarities and differences in the Negro dentition and Caucasian dentition. The following measurements and relationships were studied:

1. Maxillary and mandibular arch length -- The length of the dental arch on a straight line from the molar region to the contact point of the central incisors.
2. Maxillary and mandibular intermolar width -- The width across the arch in the molar region.
3. Maxillary and mandibular interpremolar width -- The width across the arch in the first and second premolar regions.
4. Maxillary and mandibular intercanine width -- The width across the arch in the canine region.
5. Palatal depth -- The depth of the palatal vault from the occlusal plane to the deepest portion of the hard palate.

6. Anterior overbite -- The superior-inferior relationship of the incisal edges of the maxillary incisors to mandibular incisors.
7. Anterior overjet -- The antero-posterior relationship of the incisal edges of the maxillary incisors to the mandibular incisors.
8. Mandibular anterior discrepancy -- The arch length discrepancy from the mesial of the right canine to the mesial of the opposite canine in the mandibular arch.
9. Curve of Spee -- The degree to which the mandibular occlusal plane varies from a flat plane.
10. Maxillary and mandibular basal arch length -- The midline length of maxillary and mandibular bony support of the dentition.
11. Maxillary first molar to mandibular first molar relation -- The mesiodistal relation of the maxillary molar to the mandibular molar.
12. Maxillary canine to mandibular canine relation -- The mesiodistal relation of the maxillary canine to the mandibular canine.

Palatal depth and maxillary and mandibular midline basal arch lengths were not considered by previous investigators (W. Thomas, 1966; C.J. Red, 1967).

D. Determination of linear relationships:

The devices used in the cast analyses were the following:

1. Boley gauge with a vernier scale to 0.1 millimeters
2. Steel millimeter rule calibrated to 0.5 millimeters
3. Unitek clear plastic arch symmetry grid
4. Length of straight stainless steel wire, .030 in. in thickness
5. Length of straight stainless stell wire, .045 in. in thickness
6. Sharp pencil

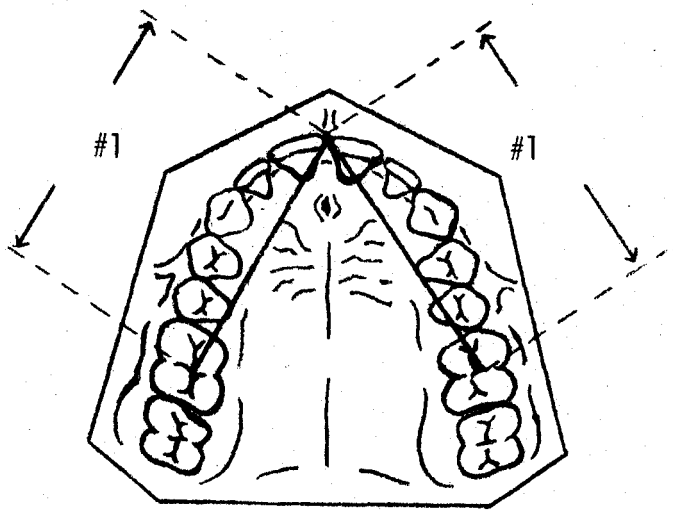
The parallel beaks of the Boley gauge were reduced to sharp points. This was achieved by reducing their external surfaces only so as not to affect the accuracy of the instrument. Holes were drilled in the arch symmetry grid along the midline large enough to accept the .045 in. length of stainless steel wire snugly. This apparatus was used in the palatal depth determination. A data sheet was designed so that information could be recorded in tabular form (Appendices I and II). Measurements made with the Boley gauge were read directly from its scale and recorded as such.

The methods used to determine the relationships previously defined are as follows:

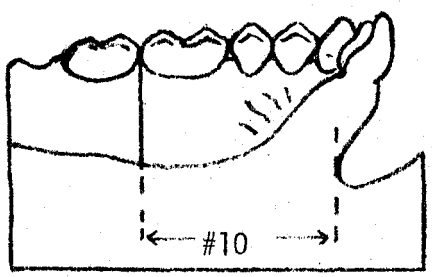
1. Arch length -- One sharpened beak of the Boley gauge was positioned in the central pit of the first molar, the other, at the incisoproximal contact of the central incisors. Both

sides of the arch were measured in this manner and added together for total arch length. If a broken contact, or diastema, was present between incisors, the beak point was positioned midway mesiodistally and buccolingually (FIG. 1a and 2a).

2. Intermolar width -- The sharpened beaks of the Boley gauge were placed in the central pits of opposite molars. The values were recorded directly on the data sheet. In those teeth where the occlusal surfaces had been restored, the beaks were placed in the center of the occlusal surface opposite the buccal grooves in maxillary molars and lingual grooves in mandibular molars.
3. Interpremolar width -- In the maxillary arch, the beaks of the Boley gauge were placed in the center of the central groove of opposite premolars. In the mandibular arch, the beaks were positioned on the tips of opposite buccal cusps. In those cases where the cusp tips had been worn by attrition, the center of the flattened area was taken as the measuring point. The distance was noted and recorded.
4. Intercanine width -- The beaks of the Boley gauge were positioned on the cusp tips of opposite canines. In those cases where the tips of the cusps had been worn due to attrition, the center of the flattened area was taken as the measuring points.



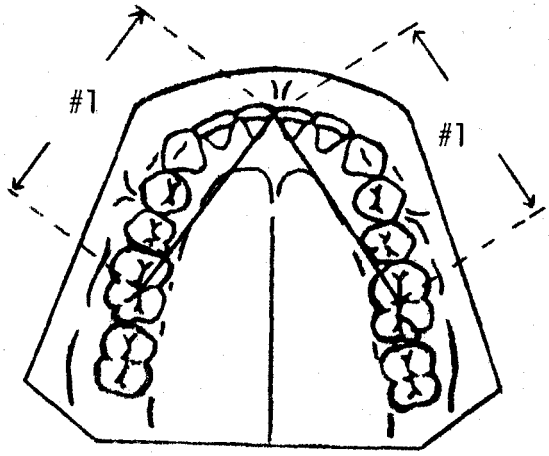
a. Occlusal View



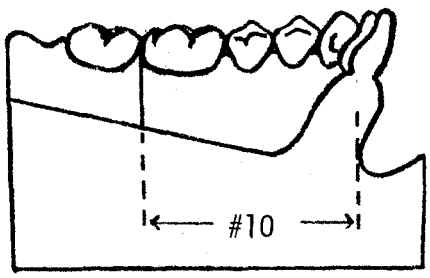
b. Mid-Saggital Section

FIGURE 1

Maxillary Linear Measurements



a. Occlusal View



b. Mid-Saggital Section

FIGURE 2

Mandibular Linear Measurements

5. Palatal depth -- The Unitek arch symmetry grid was placed on the occlusal surfaces of the premolars and first molars on the maxillary cast. The length of .045 in. wire was pushed through one of the midline holes in the grid until it contacted the deepest portion of the hard palate. Since a friction grip existed between the wire and the grid surface, there was no problem keeping the pin stationary while the grid was removed and the pin length from the bottom surface of the grid was measured with the millimeter rule.
6. Overbite -- Each set of casts were placed in occlusion and viewed directly from the front so that the occlusal plane was level with the investigator's eyes. The vertical overlap of the maxillary central incisors was marked with the tip of the sharp pencil on the labial surface of the mandibular left central incisor. The distance from the mark to the incisal edge of the tooth was measured and recorded.
7. Overjet -- With the casts in occlusion, the distance from the labial surface of the mandibular incisors to the linguoincisal edge of the maxillary central incisors was measured and recorded. Attritional wear of the maxillary incisors was not considered since so few cases exhibited any.
8. Mandibular anterior discrepancy -- The Boley gauge was used to measure the amount of interproximal overlapping due to rotated or displaced teeth from the mesial of one mandibular

canine to the mesial of the opposite canine.

9. Curve of Spee -- The mandibular cast was held at eye level with one side of the arch facing the investigator; the symmetry grid was placed on the occlusal surfaces so as to make contact with the highest tooth in the incisor region. The millimeter rule was then used to measure the distance from the tip of the tooth most inferior to the under surface of the grid. The same procedure was followed for the opposite side. The values for both sides were added together and the average determined. The average was recorded.

10. Basal arch length -- The length of .030 in. straight stainless steel wire was placed across the distal surfaces of the first molars. Then the center of this wire was projected vertically to the midline of the palate on the maxillary cast, and to a midline point on the mandibular model, approximately on the same plane as B point (Downs). The distance from these midline points to the most anterior point of the basal arch (corresponding with Downs' A point and B point) was measured with the hollow beaks of the Boley gauge. These measurements were noted and recorded (FIG. 1b and 2b).

11. Maxillary first molar to mandibular first molar relation -- With the casts in occlusion, the relationship of the mesial buccal cusp of the maxillary first molar to the buccal groove of the mandibular first molar was considered. If the

mesiobuccal cusp tip of the maxillary molar fit directly in the buccal groove of the mandibular molar, a zero was entered on the data sheet. If the cusp tip did not fall directly in the groove, the distance from the cusp tip to the groove was measured in millimeters. If the cusp tip was distal to the groove, a negative value was recorded; if mesial, a positive value recorded. This procedure was followed for both right and left sides and recorded as such on the data sheet.

12. Maxillary canine to mandibular canine relation -- With the cases in occlusion, the relationship of the maxillary canine cusp tip to the embrasure between the mandibular canine and first premolar was evaluated. If the cusp tip of the maxillary canine fit directly into this embrasure, a zero was recorded. If this did not occur, then the distance of the cusp tip from the center of the embrasure was measured with the Boley gauge. If the cusp tip was distal, a negative value was recorded; if mesial, a positive value was recorded. Both right and left sides were evaluated and recorded separately on the data sheet.
13. Ratio of basal arch length to arch length -- The ratio represents the length of the basal arch measured in the midline divided by the total arch length, and is expressed as a decimal fraction. Both maxillary and mandibular arches

were considered (Appendix III).

Methods of determining arch length, maxillary interpremolar widths, and mandibular anterior discrepancy differed from previous investigations (W. Thomas, 1966; C.J. Red, 1967).

E. Statistical Treatment of the Data:

The primary purpose of this investigation was to compare or determine the variations and/or similarities between the normal dentition of the adult Negro male and the adult Caucasian male. The population included thirty-one Negro males and fifty Caucasian males.

All the data collected from the linear measurements of these samples were analyzed, from which the mean, experimental range, and standard deviation were determined for each measurement in each group (TABLE 1). Comparison of each group, Caucasians and Negroes, was accomplished using the recognized student "t" test and probability scores for significant difference between the samples.

CHAPTER IV

FINDINGS

The statistical analysis of the data obtained in this study is found in TABLES 1, 2 and 3. TABLE 1 represents the ranges of the twenty-three measurements, the mean, standard deviation, and 95% confidence limits (mean $\pm$ 1.96 x standard deviation). TABLE 2 represents the range of the ratios of the midline basal arch length of the maxillary cast to the total maxillary arch length, and of the midline basal arch length, the mean, standard deviation, and 95% confidence limits. TABLE 3 represents the comparison of the normal adult Caucasian male dentitions and the normal adult Negro dentitions using the student "t" test. Both the "t" value and the degree of probability are listed in TABLE 3.

All cases selected for this study had a Class I (Angle) molar relation bilaterally. Each set of casts was examined for exact interdigitation of the mesiobuccal cusp of the maxillary first molar with the buccal groove of the mandibular first molar. In the Caucasian sample, fifteen casts showed ideal intercuspation on both right and left sides. In seven of the cases, one side was in ideal relation while the other had the maxillary molar slightly anterior to the buccal groove. In seven cases, the mesiobuccal cusps of both maxillary molars were slightly anterior to the buccal groove of the mandibular molar. Fourteen

TABLE 1

Statistical Evaluation
Differences Between Casts of Caucasian and Negro Dentitions

Measurements		Exp. Range	Mean	S.D.	95% Confidence Limits Low	High
Max. Arch Length	a)	68.8 to 85.1	76.83	11.13	54.57	93.66
	b)	77.3 to 94.1	85.65	4.00	77.65	93.65
Mand. Arch Length	a)	61.7 to 75.3	69.57	3.31	62.95	76.19
	b)	61.1 to 86.2	76.07	4.21	67.66	84.48
Max. Inter-Canine Width	a)	30.2 to 39.5	34.98	2.21	30.55	39.40
	b)	32.7 to 39.7	36.43	1.85	32.74	40.12
Mand. Inter-canine Width	a)	21.9 to 36.5	26.34	2.57	21.21	31.47
	b)	22.9 to 31.0	27.86	2.01	23.85	31.87
Max. First Inter-premolar Width	a)	37.0 to 46.8	42.50	2.45	37.59	47.51
	b)	35.6 to 43.8	39.31	2.29	34.73	43.88
Max. Second Inter-premolar Width	a)	42.0 to 53.2	48.17	2.82	42.52	53.82
	b)	34.9 to 50.2	44.15	8.65	26.85	61.45
Mand. First Inter-premolar Width	a)	29.2 to 38.5	34.19	2.32	29.54	38.83
	b)	32.8 to 42.9	36.54	2.17	32.20	40.88
Mand. Second Inter-premolar Width	a)	34.2 to 44.5	40.78	5.14	30.50	51.07
	b)	36.7 to 47.0	42.22	2.69	36.84	47.60
Max. First Inter-molar Width	a)	41.4 to 54.0	47.66	3.31	41.04	54.28
	b)	45.9 to 59.3	50.75	2.97	44.82	56.69
Max. Second Inter-molar Width	a)	46.8 to 60.4	53.98	15.06	23.86	84.10
	b)	49.4 to 61.8	54.79	14.06	26.67	82.91

a) Caucasian
b) Negro

TABLE 1 (continued)

Measurements		Exp. Range	Mean	S.D.	95% Confidence Limits Low	High
Mand. First Intermolar Width	a)	35.4 to 46.5	42.56	4.93	32.71	52.42
	b)	38.9 to 48.3	43.75	2.64	38.48	49.02
Mand. Second Intermolar Width	a)	42.0 to 53.7	48.74	5.13	38.49	58.99
	b)	44.6 to 54.2	49.05	2.50	44.04	54.05
Palatal Depth	a)	11.0 to 23.0	19.88	3.06	13.76	26.00
	b)	15.8 to 22.8	19.56	1.90	15.77	23.36
Incisor Overjet	a)	0.0 to 3.5	1.51	1.01	-0.51	3.53
	b)	0.5 to 4.5	2.24	0.85	0.54	3.94
Incisor Overbite	a)	0.0 to 5.0	2.97	1.22	0.53	5.41
	b)	0.5 to 4.5	3.45	5.05	-6.64	13.55
Curve of Spee	a)	0.0 to 2.5	0.83	0.59	-0.36	2.01
	b)	0.0 to 1.8	0.72	0.50	-0.28	1.72
First Molar Relation-Right	a)	-2.5 to 2.5	0.00	1.16	-2.32	2.32
	b)	-3.2 to 1.5	-0.21	1.18	-2.59	2.15
First Molar Relation-Left	a)	-2.7 to 2.0	-0.05	1.02	-2.10	1.99
	b)	-2.9 to 1.7	-0.39	1.04	-2.42	1.65
Canine Relation-Right	a)	-1.5 to 4.0	0.90	1.37	-1.83	3.65
	b)	-1.4 to 3.4	0.92	1.10	-1.29	3.13
Canine Relation-Left	a)	-1.4 to 4.2	1.32	1.25	-1.18	3.83
	b)	0.0 to 3.5	0.95	1.06	-1.16	3.07
Max. Midline Basal Arch Length	a)	28.7 to 39.5	34.81	2.30	30.21	39.40
	b)	28.6 to 37.7	34.34	2.49	29.36	39.33
Mand. Midline Basal Arch Length	a)	26.3 to 35.4	31.70	2.07	27.57	38.83
	b)	26.5 to 37.6	32.51	2.43	27.65	37.37
Mand. Anterior Descrepancy	a)	0.0 to 5.0	2.17	0.96	0.25	4.09
	b)	0.0 to 5.0	1.34	1.35	-1.35	4.03

a) Caucasian b) Negro

casts showed an ideal relation on one side while the maxillary molar was slightly posterior to the buccal groove on the opposite side. In four cases the maxillary molars on both sides were slightly posterior. In three cases, the maxillary molar on one side was slightly posterior and the maxillary molar on the opposite side was anterior.

In the Negro sample, six of the casts showed ideal intercuspation of both right and left sides. In six cases one side was in ideal relation while the other side had the maxillary molar slightly anterior. In three cases the mesiobuccal cusps of both molars were slightly anterior to the buccal grooves of the mandibular molars. Five casts showed an ideal relation on one side while the maxillary molar was posterior to the buccal groove of the mandibular molar on the opposite side. In nine cases, the maxillary molars were posterior on both sides. In two cases, the maxillary molar was slightly posterior on one side and slightly anterior on the opposite side.

These slight deviations from "normal" Class I molar relations seen in these samples were not of sufficient magnitude to disqualify a case from a classification of normal occlusion. In those cases showing some deviation in molar relationships, the premolars were in perfect intercuspation, indicating that mesial drift of the buccal segments was not the cause of molar variation.

Each case was examined in centric occlusion to determine the relation of the maxillary canine to the embrasure between the mandibular canine and first premolar. In the Caucasian sample, nine casts showed

ideal interdigitation. In eighteen of the subjects, the relationship on one side was ideal while the cusp tip was slightly anterior to the embrasure on the other. Twenty casts had the cusp tips anterior to the embrasure on both sides of the arch. In one case the maxillary cusp tip was posterior to the embrasure on one side and ideally located on the other side. Both maxillary canines were distal in one case and another had the maxillary canine mesial on one side and distal on the opposite side of the arch.

In the Negro sample, an ideal relation of the maxillary canine cusp tip and the mandibular embrasure existed in four cases. Twelve subjects had an ideal canine relation on one side while the cusp tip was slightly anterior to the embrasure on the other side. Thirteen cases had the cusp tips anterior to their respective embrasures on both sides of the arch. Only one case showed an ideal intercuspation on one side and the maxillary cusp tip slightly posterior to the mandibular embrasure on the opposite side. One case had the maxillary canine on the right distal to the mandibular embrasure and the maxillary canine on the left mesial to the mandibular embrasure.

In all cases where the maxillary canines were forward, the pre-molar occlusal relationship was normal, indicating that mesial drift of the maxillary buccal units did not cause the forward position of the canines. Sixty-five of the samples in both groups had one or both molars forward; but even in these cases the premolar occlusion was quite normal. This fact points out that mesial drift of the maxillary buccal

TABLE 2

Statistical Evaluation

Ratio: $\frac{\text{Midline Basal Arch Length}}{\text{Arch Length}}$

		Exp. Range	Mean	S.D.	95% Confidence Limits Low	High
Maxillary Cast	a)	0.37 to 0.50	0.44	0.03	0.38	0.49
	b)	0.36 to 0.44	0.40	0.03	0.35	0.46
Mandibular Cast	a)	0.41 to 0.53	0.46	0.03	0.39	0.52
	b)	0.35 to 0.56	0.43	0.04	0.36	0.50

a) Caucasian
b) Negro

segments was not the cause of the mesial positioning of the molars and canines. These occlusal adjustment can be explained by tooth size differentials.

The total dental arch lengths of the maxillary and mandibular casts were determined. The mean maxillary arch length of the Caucasian males was 76.8 millimeters, with a range of 54.6 to 93.7 millimeters*; the mean mandibular arch length for the same group was 69.6 millimeters with a range of 62.9 to 76.2 millimeters. As expected, these varied significantly from the Negro sample whose mean maxillary arch length was

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*95% Confidence Limits

85.65 millimeters with a range of 77.65 to 93.65 millimeters, and the mean mandibular arch length was 76.07 millimeters, 67.7 to 84.5 millimeter range.

The mean maxillary intercanine width of the Caucasian group was 34.98 millimeters, with a range of 30.55 to 39.40 millimeters. For the Negro sample, the mean maxillary intercanine width was 36.43 millimeters, 32.74 to 40.12 millimeter range. Intercanine distance in the Negro was significantly larger.

The same can be said of the mandibular intercanine distance. The mean in the Negro was 27.86 millimeters with a range of 23.85 to 31.87 millimeters, while in the Caucasian, the mean was 26.34 millimeters, and a 21.21 to 31.47 millimeter range.

Maxillary interpremolar widths were signficiantly larger in the Caucasian group. The mean first interpremolar width was 42.50 millimeters, having a range of 37.59 to 47.51 millimeters as compared to the Negro group, a mean of 39.31 millimeters and a range of 34.73 to 43.88 millimeters. So too, the mean second interpremolar width in the Caucasian group was 48.17 millimeters with a range of 42.52 to 53.82 millimeters; while the Negro sample exhibited a mean of 44.15 millimeters and a range of 26.85 to 61.45 millimeters.

However, in the mandibular arch, the first interpremolar width was significantly larger in the Negro, a mean of 36.54 millimeters and a range of 32.20 to 40.88 millimeters, as compared to 34.19 millimeter mean and a 29.54 to 38.83 millimeter range. Mandibular second

TABLE 3

Statistical Evaluation

Critical Values of t

Comparison of Casts of Caucasian and Negro Dentitions

Measurements	t Values	Probability
Max. Arch Length	4.237	P 0.001
Mand. Arch Length	7.736	P 0.001
Max. Intercanine Width	3.047	P 0.001
Mand. Intercanine Width	2.799	P 0.01
Max. First Interpremolar Width	5.841	P 0.001
Max. Second Interpremolar Width	4.159	P 0.001
Mand. First Interpremolar Width	4.544	P 0.001
Mand. Second Interpremolar Width	1.438	P 0.10
Max. First Intermolar Width	4.247	P 0.001
Max. Second Intermolar Width	0.527	P 0.50
Mand. First Intermolar Width	1.231	P 0.10
Mand. Second Intermolar Width	0.305	P 0.50
Palatal Depth	0.520	P 0.50
Incisor Overjet	3.357	P 0.001
Curve of Spee	0.838	P 0.50
First Molar Relation-Right	0.826	P 0.50
First Molar Relation-Left	1.441	P 0.10
Canine Relation-Right	0.064	P 0.50
Incisor Overbite	0.647	P 0.50

TABLE 3 (continued)

Measurements	t Values	Probability
Canine Relation-Left	1.363	P 0.10
Max. Midline Basal Arch Length	0.863	P 0.50
Mand. Midline Basal Arch Length	1.598	P 0.10
Mand. Anterior Discrepancy	3.225	P 0.001
Ratio Max. Midline Basal Arch Length/Arch Length	6.647	P 0.001
Ratio Mand. Midline Basal Arch Length/Arch Length	3.799	P 0.001

interpremolar width did not vary significantly between the races.

Intermolar width was significantly larger in the Negro sample in the maxillary first molar region only. The mean for the Caucasian was 47.66 millimeters, with a range of 41.04 to 54.28 millimeters, as compared to the larger mean of 50.75 millimeters, range, 44.82 to 56.69 millimeters, in the Negro. Mandibular first intermolar width, along with maxillary and mandibular second intermolar widths, did not vary significantly between the groups.

Mandibular anterior discrepancy was greater in the Caucasian sample with a mean of 2.17 millimeters and a range of 0.25 to 4.09 millimeters. For the Negro group, the mean was 1.34 millimeters, range, -1.35 to 4.03 millimeters. The negative value in the range represents spacing in the mandibular anterior region.

The midline basal arch length of the maxillary and mandibular casts were determined for each subject in each group (Appendix III).

A mean of 34.81 millimeters, a range of 30.21 to 38.40 millimeters in the maxilla, and a mean of 31.70 millimeters and a range of 27.57 to 38.83 millimeters in the mandible were determined for the Caucasian. In the Negro a mean of 34.34 millimeters with a range of 29.36 to 39.33 millimeters in the maxilla, and a mean of 32.51 millimeters with a range of 27.65 to 37.37 millimeters in the mandible were determined as normal observations. The two norms did not vary significantly from each other.

A ratio of midline basal arch length to total arch length was established. The midline basal arch length of the maxillary cast was divided by the total dental arch length of the maxillary cast. The same procedure was followed for the mandibular casts. The results can be found in TABLE 2. This ratio suggests the amount of tooth material supported by the basal bone. If the ratio is large, the normal dentition can be assumed to have adqauate support and therefore be more favorably situated antero-posteriorly. All other factors being normal, if the ratio is small, then the supporting structure of the dentition is minimal and the crowns of the anterior teeth must project forward in order to be accommodated in a normal arch form.

CHAPTER V

DISCUSSION

A. General Considerations:

An important consideration in the diagnosis and treatment planning in clinical orthodontics is an understanding of the normal relationship between the facial profile and denture. Data published for one racial group are often used in planning treatment of other racial groups. There are obvious differences in the configurations of the soft and hard tissues of the face in these groups.

This investigation was designed to point up the similarities and variations of the normal dental structures of the North American Negro male and the North American Caucasian male.

Young adults were chosen for this study because their arch form and tooth arrangement is determined and should remain relatively stable. Occlusal phenomena and boney structures are subject to changes incident to growth, which may work to influence favorably or alter unfavorably the development of occlusion until a person reaches maturity.

The dentitions of the subjects used in this investigation conformed to the requirements in the chapter on materials and methods. Properly articulated plaster models of each subject were constructed. Measurements were taken from certain landmarks on each set of casts in order to determine the variations of the values for each landmark within

each population.

Mean values were calculated for each measurement. Because of the individual variation within the races, no denture can be expected to comply with all, or indeed any, of the mean values determined here. However, a range for each measurement was established as a framework within which a value can vary and still remain an acceptable normal value.

The term normal occlusion implies the existence of a molar relation consistent with an anterior overjet of two or three millimeters, assuming normal alignment in both arches. It follows that a Class I (Angle) molar relation of the maxillary and mandibular anterior teeth is to be esthetically and functionally correct. All of these cases in the study had the first molars in neutrocclusion.

B. Discussion of the findings:

The total dental arch lengths of the maxillary and mandibular casts were determined. It was found that maxillary and mandibular arch length was significantly larger in the Negro male adult. Red (1967) showed that the normal mesiodistal widths of the teeth of Negro adults are significantly larger than those of Caucasians. Therefore, it follows that the respective arch length would also be larger.

The arch breadth in the canine, premolar, and molar regions was determined. The widths in the canine region and first molar region of the maxillary arch were significantly larger in the Negro than in the Caucasian. This was true of the mandibular arch in the canine region. The maxillary and mandibular second intermolar widths were not significantly

different between the races. Surprisingly the maxillary inter-premolar distances were larger in the Caucasian than in the Negro. Maxillary arch form, then, of the Negro can be said to be broader in the anterior region, narrower in the premolar region, and broader in the first molar region, indicating a tendency toward a square arch form.

Palatal depth did not vary significantly between the races.

Incisor overjet varied significantly between the groups, the Negro sample having a mean overjet of 2.24 millimeters versus a 1.51 millimeter mean overjet in the Caucasian sample. Both samples showed great variability within the five millimeter restriction imposed on this measurement in the selection of the samples. Iyer and Desai (1963) in their study of the normal occlusion of the Indian male, determined that a mean overjet of 2.4 millimeters with a range of 0.5 to 5.5 millimeters was normal for this group. A minimal amount of overjet can be observed clinically when the canine teeth are in a Class I relation and all anterior teeth in both arches in tight contact. Several arrangements of the anterior teeth can prevent good overjet even though the canines are in a Class I relation. These are (1) tooth mass discrepancies between the maxillary and mandibular anterior teeth; (2) broken contact points due to crowding in the mandibular anterior teeth; (3) spacing of the maxillary anterior teeth; and (4) a combination of the above. Because of these variables, increased overjet cannot be considered as being a characteristic of the Negro dentition.

The position of the mesiobuccal cusp of the maxillary first molar

in relation to the buccal groove of the mandibular first molar did not vary significantly between the groups, indicating a Class I (Angle) molar relation with a slight variation anterior or posterior is acceptable for both groups. So too, the canine relationships did not vary significantly between the groups.

On canine occlusion, only five subjects from both groups had end-to-end canine occlusion, and in only one case was this condition bilateral. On the other hand, Iyer and Desai (1963), in their examination of casts of one hundred Indian males (from the University of Bombay, India) with normal occlusion, showed that one-half of their subjects had normal canine relationships and the other half end-to-end canine relation. They suggested that some discrepancy in size of the maxillary and mandibular teeth might account for this relationship. My contention is that the criteria in sample selection were not as rigid as those used in selecting the samples for this paper.

The mesiodistal angulation of the maxillary canine has a definite bearing on the mesiodistal position of the cusp tip of the tooth. Similar observations were made by Iyer and Desai (1963) and W. Thomas (1966). Thomas demonstrated a wide range of canine angulation (maxillary 102.1°, to 69.9°; mandibular 110° to 71°) in his study. It must be concluded that mesially or distally tipped canines are frequently seen in subjects having normal occlusion.

The midline lengths of the basal arch of the maxilla were remarkably similar in both groups, indicating the size of the maxillary

supporting bone, anteroposteriorly, is similar in both races. The same could be said of the mandible. However, when considering the differences in dental arch length previously pointed out, one would suspect either crowding of the teeth in the Negro, or labial inclination of the anterior teeth producing a dental procumbancy. Noting too, the significantly smaller ratios in the Negro of midline basal arch length to total dental arch length (TABLE 2) tends to bear out this assumption. Altemus (1960) in a study of cephalofacial relationships of North American Negro children found that the degree and nature of the prognatism attributed to the Negro is a dental prognatism. The chin point as related to the facial plane is similar to that of the orthognathious face of the Caucasian.

Sassouni (1960) found that the molars occupy a similar position in the Caucasian and Negro. In Negroes, however, the incisors are more procumbant and the denture is more protrusive. He also found that the maxilla (ANS-PNS) in Negroes is the same size as in Whites; however, the body of the mandible is longer antero-posteriorly in Negroes.

The final significant finding worth discussion is the mandibular anterior arch length discrepancy. The Caucasian group showed a significantly greater discrepancy than the Negro, with a mean of 2.17 millimeters versus a mean of 1.34 millimeters in the Negro sample. The older mean age of the Caucasian group could account for this phenomenon, as this crowding is a sign of aging in the dentition. However, the fact of the differences in lip posture and touns between the races could also be

a contributing factor.

Taking into consideration what has been said, it can be concluded that the normal Negro dentition is procumbant. Whether or not this situation is esthetically pleasing is another question. However, the incisor teeth of the Negro are stable in this procumbant position, contrary to what is believed of the Caucasian incisors. This variation is one of adaptation, since the Negro teeth are larger mesiodistally than those of the Caucasian with the supporting bony structures of each similar in size. It follows then that the balancing forces of the tongue and perioral musculature must vary in magnitude between the races. Treatment goals, then, must be altered to accommodate these forces otherwise failure is inevitable.

CHAPTER VI

SUMMARY AND CONCLUSIONS

A. Summary:

This was an investigation to determine the similarities and variations of the acceptable normal dentitions of the adult Caucasian male and adult Negro male, and to evaluate these factors statistically.

Fifty plaster casts of normal Caucasian male dentitions and thirty-one casts of normal Negro male dentitions were studied. The mean age of the Caucasian sample was 25.5 years and of the Negro group was 16.3 years. These participants fulfilled certain requirements with regard to morphology and function of the craniofaciodental complex as set forth in this experiment.

Twenty-three linear measurements were made on the casts of the two groups to provide a basis for an understanding of the similarities and differences between the normal Caucasian and normal Negro dentitions. The statistical analysis of the data obtained in this study represents the ranges of twenty-three measurements, the mean, standard deviation, and 95% confidence limits for the range of each value. The student "t" test was used in the comparison of the normal Caucasian and normal Negro dentitions. Both the "t" value and degree of probability were determined.

B. Conclusions:

The following may be concluded from this study:

1. Variations from the normal occur in all human dentitions. A description of normal occlusion can only serve as a guide for comparison with "individual normal" occlusion.
2. Both maxillary and mandibular arch length are significantly greater in the North American Negro than in the North American Caucasian.
3. The arch form in the maxillary arch of the Negro is broader in the anterior and molar regions and narrower in the premolar regions when compared to the Caucasian.
4. Premolar occlusion is less variable than canine and molar occlusion. This is true for both groups.
5. Although incisor overjet was significantly greater for the Negro, too many variables prevented a true evaluation of this fact.
6. A small amount of anterior crowding is more likely to be seen in the Caucasian than in the Negro.
7. The midline length of the basal arches were remarkably similar in size in both groups, even though the dental arch length is greater in the Negro.
8. The procumbancy of the Negro is mainly a dental procumbancy produced by large teeth with a proportionately lesser amount of basal supporting bone anteroposteriorly.

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APPENDIX I

Linear Measurements

Cauc. Subj.	Max. Arch Length	Mand. Arch Length	Max. Inter-Canine Width	Man. Inter-Can. Width	Max. First Inter-Pre. Width	Max. Second Inter-Pre. Width
1	75.9 mm	68.9 mm	32.8 mm	24.3 mm	41.5 mm	46.3 mm
2	76.0	68.7	25.4	41.2	41.2	48.2
3	77.9	70.3	33.5	24.3	41.7	49.4
4	72.5	65.6	34.5	25.0	43.2	49.1
5	84.9	74.9	38.4	28.2	42.8	43.9
6	75.7	61.7	35.0	23.5	43.7	48.9
7	72.3	71.0	32.3	25.4	37.8	43.5
8	78.9	68.1	37.8	27.5	46.3	51.2
9	72.9	68.0	32.5	27.2	38.5	43.4
10	74.5	65.6	32.8	25.0	41.5	46.6
11	79.7	70.3	39.5	29.8	46.4	51.2
12	74.3	65.1	33.8	24.6	40.6	46.4
13	75.8	67.3	33.3	22.5	40.8	47.5
14	88.8	75.3	39.2	28.8	44.4	49.0
15	83.4	73.8	35.6	36.5	45.0	51.5
16	79.6	68.1	36.3	25.5	44.8	48.5
17	81.0	72.6	36.5	30.3	46.8	51.8
18	78.0	69.0	34.3	23.5	39.5	42.0
19	78.0	65.5	32.5	23.5	41.0	49.0
20	82.0	73.2	33.8	29.0	40.0	45.5
21	73.2	66.0	33.0	25.2	43.2	48.0
22	78.3	67.3	34.3	25.4	41.0	46.8
23	82.5	70.6	38.0	26.6	47.3	53.2
24	78.8	69.6	35.3	27.5	43.2	48.7
25	82.5	74.0	34.0	26.5	42.5	47.8
26	82.6	73.5	35.5	26.3	43.5	50.7
27	76.9	68.3	38.0	27.3	44.8	50.9
28	77.5	68.9	33.2	26.5	39.5	46.2
29	72.3	65.3	31.2	31.9	39.6	44.5
30	82.0	74.3	35.6	23.8	43.0	50.0
31	79.8	73.7	38.3	28.8	46.0	52.4
32	77.7	68.5	36.4	27.0	43.3	47.7
33	76.6	68.8	33.2	24.6	41.7	46.9
34	72.6	73.2	33.3	23.7	40.5	46.2
35	82.3	74.9	34.0	25.2	43.0	48.0
36	77.9	67.0	35.4	25.2	44.0	50.9
37	87.7	75.2	38.7	28.3	46.0	51.9
38	79.2	67.2	35.8	26.4	44.0	51.7
39	76.2	67.2	33.5	22.0	38.5	44.0
40	68.8	64.4	30.2	22.7	37.0	42.0

APPENDIX I (continued)

Cauc. Subj.	Max. Arch Length	Mand.Arch Length	Max. Inter-Canine Width	Man.Inter-Can. Width	Max.First Inter-Pre. Width	Max. Second Inter-Pre. Width
41	83.5 mm	70.0 mm	37.0 mm	26.5 mm	43.5 mm	46.5 mm
42	75.0	68.6	35.0	26.7	43.5	49.6
43	85.1	75.0	35.0	25.5	43.0	51.5
44	79.6	68.6	33.5	27.0	41.0	48.0
45	75.5	66.5	32.0	24.6	40.8	47.0
46	77.0	66.5	35.0	25.9	39.7	45.5
47	80.3	70.5	35.8	27.0	42.0	46.5
48	77.8	70.4	35.8	27.0	42.7	49.5
49	79.7	70.0	34.7	26.7	43.2	50.5
50	80.4	71.3	39.5	30.0	46.5	62.4

Cauc. Subj.	Mand. 1st Inter-Pre-Molar Width	Mand. 2nd Inter-Pre-Molar Width	Max. First Intermolar Width	Max. Second Intermolar Width	Mand. First Intermolar Width
1	33.2 mm	38.8 mm	48.0 mm	54.5 mm	41.2 mm
2	32.5	39.0	48.0	56.3	42.0
3	33.7	41.0	47.3	51.5	40.8
4	34.4	39.4	47.3	50.2	40.7
5	34.5	34.5	47.6	52.7	40.6
6	30.8	35.7	51.2	60.6	39.0
7	38.5	43.5	43.0	48.5	43.0
8	36.9	41.8	49.2	54.6	44.8
9	35.7	42.2	43.0	48.9	46.0
10	34.3	38.0	46.4	52.8	40.7
11	37.0	41.8	50.8	55.6	43.5
12	31.0	36.3	47.5	53.0	39.6
13	32.6	39.4	49.6	54.3	43.7
14	35.0	40.0	47.5	--	40.6
15	36.3	43.8	52.0	56.4	46.2
16	34.6	41.5	47.7	53.5	41.4
17	37.0	44.4	50.7	54.0	44.6
18	31.5	37.4	43.3	47.0	37.5
19	31.5	38.7	50.5	55.9	44.0
20	32.5	37.7	46.2	--	39.8
21	34.5	39.3	45.2	49.4	39.5
22	35.5	42.0	48.0	52.8	43.3

APPENDIX I (continued)

Cauc. Subj.	Mand. 1st Inter-Pre-Molar Width	Mand. 2nd Inter-Pre-Molar Width	Max. First Intermolar Width	Max. Second Intermolar Width	Mand. First Intermolar Width
23	35.6 mm	42.7 mm	51.0 mm	56.3 mm	44.0 mm
24	37.5	41.5	47.3	52.8	41.8
25	34.5	39.7	48.5	54.5	42.5
26	35.0	40.6	50.6	56.7	43.3
27	36.8	41.4	47.3	55.5	41.8
28	30.0	39.6	46.8	54.6	40.5
29	29.2	36.9	45.6	52.3	39.7
30	33.7	42.6	48.6	54.7	41.4
31	37.3	43.6	52.0	57.5	46.4
32	35.2	39.8	45.4	55.7	38.0
33	35.1	39.6	48.4	57.5	41.3
34	32.8	40.0	43.0	50.0	38.5
35	33.3	37.3	47.0	54.4	40.6
36	35.5	41.8	50.6	56.2	43.8
37	35.6	41.9	50.3	57.9	44.0
38	36.3	43.0	51.0	57.5	45.7
39	29.9	35.3	45.5	51.7	38.9
40	29.4	34.2	41.4	46.8	35.4
41	35.5	41.7	44.2	52.3	37.7
42	37.0	42.5	51.3	--	45.0
43	35.0	42.6	52.3	57.3	45.0
44	35.0	42.8	47.3	55.0	43.3
45	33.0	38.8	41.5	50.7	41.7
46	30.3	36.9	46.5	56.5	38.5
47	33.0	39.2	36.7	52.0	40.7
48	32.4	39.5	48.6	55.0	42.5
49	35.0	43.3	50.5	55.7	46.5
50	37.0	44.5	54.0	--	46.2

Cauc. Subj.	Mand. 2nd Intermolar Width	Palatal Depth	Incisor Overjet	Incisor Overbite	Curve of Spee	1st Molar Relation-Right	1st Molar Relation -Left
1	49.0 mm	22.0 mm	3.0 mm	5.0 mm	1.0 mm	0.0 mm	2.0 mm
2	50.3	18.0	3.0	2.0	0.5	1.1	1.9
3	48.7	20.0	0.5	3.5	0.5	1.7	1.3

APPENDIX I (continued)

Cauc. Subj.	Mand. 2nd Intermolar Width	Palatal Depth	Incisor Overjet	Incisor Overbite	Curve of Spee	1st Molar Relation-Right	1st Molar Relation -Left
4	44.5	18.0	0.5	3.5	0.5	0.0	0.0
5	47.4	21.0	2.0	4.0	1.5	0.0	0.0
6	44.2	22.0	3.0	2.0	0.0	0.0	0.0
7	47.3	13.0	2.0	4.5	1.0	2.2	1.4
8	48.7	20.0	3.5	0.5	1.0	0.0	1.4
9	55.0	12.0	0.5	2.0	1.5	0.6	0.0
10	46.4	23.5	1.5	3.5	0.5	0.0	0.0
11	48.5	19.0	2.0	3.0	0.5	-1.7	0.0
12	46.0	16.0	2.0	4.0	0.5	0.0	-1.0
13	50.3	23.0	0.5	3.0	0.5	0.0	-1.0
14	46.6	20.0	0.5	3.0	0.0	0.0	0.0
15	52.4	21.0	2.5	4.0	0.5	0.0	-1.4
16	47.7	21.0	3.0	3.0	1.5	-1.5	-2.5
17	51.5	20.0	0.5	1.5	0.5	0.0	0.0
18	41.8	18.0	3.5	4.0	0.5	0.0	-1.0
19	51.0	15.5	2.0	4.0	0.5	-1.6	0.0
20	43.7	23.0	0.5	3.0	1.0	0.0	0.0
21	42.8	17.0	2.0	1.0	1.0	-1.6	0.0
22	49.9	18.0	3.0	3.5	1.5	0.0	0.0
23	49.0	18.0	3.0	4.5	2.5	0.7	0.0
24	47.5	22.5	2.0	3.0	1.5	0.0	0.0
25	48.0	23.0	2.5	3.0	0.0	0.0	0.0
26	51.2	20.5	0.5	5.0	2.0	-0.6	0.0
27	49.3	20.0	1.0	4.0	1.0	0.0	0.0
28	48.4	22.5	0.0	0.5	0.0	0.0	-1.7
29	46.4	21.0	0.5	4.0	0.5	2.3	0.9
30	47.3	20.0	1.0	4.0	0.5	2.3	-1.4
31	51.3	23.5	0.0	0.5	0.0	0.0	0.0
32	47.5	23.0	1.0	3.0	1.0	0.0	0.0
33	49.3	25.0	3.0	4.0	1.5	2.5	1.1
34	42.0	19.0	1.0	2.5	0.0	1.7	1.5
35	45.5	19.0	2.0	4.0	0.0	-1.0	0.0
36	49.8	21.0	1.5	3.0	2.0	0.0	1.0
37	49.5	21.0	1.0	3.0	1.0	-1.0	-1.6
38	51.7	21.0	2.0	4.0	2.0	0.0	-1.2
39	46.0	11.0	1.0	4.0	1.0	-1.6	-1.3
40	42.0	12.0	0.5	0.5	1.0	-017	0.0
41	45.5	21.0	2.5	2.5	1.5	1.1	1.0
42	53.7	20.0	0.5	3.0	1.0	0.0	0.0

APPENDIX I (continued)

Cauc. Subj.	Mand. 2nd Intermolar Width	Palatal Depth	Incisor Overjet	Incisor Overbite	Curve of Spee	1st Molar Realtion-Right	1st Molar Relation -Left
43	51.0	20.0	1.0	3.0	0.5	-0.7	1.0
44	50.0	23.0	1.0	2.0	1.0	0.0	0.0
45	46.4	20.5	1.0	3.0	0.5	1.0	0.0
46	47.0	20.0	0.5	3.0	0.5	-2.3	-2.7
47	46.7	22.0	1.0	2.0	1.0	-2.5	0.9
48	47.8	21.5	0.0	0.0	0.5	-2.0	0.0
49	51.0	20.0	1.5	4.0	0.5	1.7	0.0
50	52.7	22.0	1.5	2.0	0.5	0.0	-1.0

Cauc. Subj.	Canine Relation-Right	Canine Relation-Left	Max. Basal Arch Length	Mand. Basal Arch Length	Mand. Ant. Discrepancy
1	0.0 mm	4.2 mm	35.1 mm	29.8 mm	2.5 mm
2	2.0	1.9	32.0	30.0	5.0
3	3.5	4.0	37.5	33.0	1.0
4	1.4	1.5	31.3	32.8	2.0
5	1.5	2.5	39.0	26.3	3.0
6	-1.5	2.1	35.5	30.1	3.0
7	3.9	0.0	36.1	30.7	3.0
8	1.7	2.4	34.3	30.0	2.0
9	1.0	2.1	31.4	29.0	2.0
10	1.5	1.6	37.1	30.5	3.0
11	1.3	2.1	35.3	31.6	1.0
12	0.0	0.0	35.0	34.2	2.0
13	0.7	0.0	33.4	33.5	2.0
14	0.0	0.0	35.7	31.0	0.0
15	0.0	0.0	39.5	34.3	1.5
16	-1.1	-0.9	35.5	32.3	2.0
17	0.0	1.0	33.3	33.5	1.5
18	1.5	0.0	37.1	32.0	3.0
19	0.0	1.9	34.6	32.6	0.5
20	0.0	0.0	37.0	33.7	1.5
21	0.0	2.5	33.2	32.0	1.5
22	0.0	2.3	36.0	29.4	1.5
23	1.5	0.0	35.6	33.5	2.5

APPENDIX I (continued)

Cauc. Subj.	Canine Relation-Right	Canine Relation-Left	Max. Basal Arch Length	Mand. Basal Arch Length	Mand. Ant. Discrepancy
24	2.8 mm	1.8 mm	36.5 mm	32.5 mm	2.5 mm
25	1.1	1.5	38.0	31.2	1.5
26	0.0	2.0	34.8	32.0	1.0
27	0.0	1.4	32.9	32.5	1.0
28	0.0	0.0	32.2	33.3	1.5
29	1.4	1.0	33.6	31.1	1.5
30	4.0	0.0	37.1	35.4	3.5
31	0.0	0.0	34.2	30.4	2.0
32	2.2	1.6	28.7	28.0	2.5
33	2.7	3.4	34.2	29.0	3.5
34	1.5	2.0	32.9	32.0	2.0
35	0.0	1.8	37.6	34.9	1.5
36	0.0	3.0	31.5	29.1	4.0
37	0.0	0.0	36.1	35.0	3.0
38	1.1	0.0	34.2	27.3	1.5
39	0.0	0.0	30.7	33.9	2.0
40	0.0	1.4	32.5	30.2	3.0
41	1.5	2.0	36.6	34.2	2.0
42	0.7	1.8	32.9	30.6	2.0
43	0.0	1.0	37.0	33.8	2.0
44	1.6	1.0	34.6	33.4	2.0
45	1.2	2.5	34.7	32.2	2.0
46	0.0	-1.4	35.4	30.5	4.0
47	1.0	2.5	38.4	33.5	2.5
48	0.0	0.0	34.9	32.0	1.5
49	1.5	1.7	36.1	32.8	4.0
50	0.0	2.5	31.7	29.5	2.0

APPENDIX II

Linear Measurements

Negro Subj.	Max. Arch Length	Mand. Arch Length	Max. Inter-Canine Width	Man. Inter-Can. Width	Max. 1st Inter-Pre. Width	Max. 2nd Inter-Pre. Width
1	77.2 mm	76.9 mm	34.3 mm	25.5 mm	37.5 mm	44.6 mm
2	80.5	73.0	35.0	27.7	36.7	41.0
3	84.9	75.4	36.3	26.2	39.6	46.8
4	83.9	73.8	36.1	29.0	37.7	41.3
5	82.9	71.7	36.4	27.6	36.4	41.8
6	82.8	73.2	36.0	27.5	38.1	44.1
7	84.7	74.0	35.4	26.1	38.3	42.1
8	79.1	61.6	32.7	23.8	36.2	40.9
9	88.6	77.9	36.9	30.1	40.5	42.6
10	88.6	75.8	39.5	28.2	43.8	48.3
11	87.2	79.3	36.1	28.5	38.6	42.6
12	85.6	75.9	34.9	26.0	38.3	43.3
13	86.8	78.6	38.2	29.9	40.2	44.4
14	84.3	75.1	35.1	28.4	38.7	45.9
15	79.4	70.9	36.8	28.5	36.3	41.2
16	82.6	75.0	37.6	31.0	40.9	42.0
17	90.9	82.6	35.3	27.4	38.6	42.2
18	94.1	85.8	38.1	29.3	42.4	48.8
19	85.3	77.7	37.9	30.2	40.6	45.9
20	89.5	77.4	36.0	27.1	38.7	34.9
21	88.5	82.7	38.7	29.8	41.0	46.6
22	81.9	72.5	33.7	22.9	36.6	42.8
23	89.6	79.5	34.4	28.3	37.9	--
24	84.2	76.7	34.2	25.6	35.6	40.9
25	89.6	76.7	39.5	27.8	43.7	50.2
26	82.5	73.8	36.1	26.8	39.0	44.8
27	89.2	77.9	38.9	30.4	40.9	46.7
28	88.4	78.4	37.7	30.3	41.6	48.9
29	90.5	78.7	39.7	30.5	42.5	46.8
30	82.5	75.1	34.0	25.5	39.0	45.9
31	89.5	77.7	37.2	27.8	41.6	46.7

APPENDIX II (continued)

Negro Subj.	Mand. 1st Inter-Pre. Width	Mand. 2nd Inter-Pre. Width	Max. 1st Intermolar Width	Max. 2nd Intermolar Width	Mand. 1st Intermolar Width
1	35.5 mm	41.4 mm	51.9 mm	55.5 mm	45.5 mm
2	34.2	39.0	47.1	51.2	40.8
3	35.3	41.8	53.5	55.7	46.0
4	36.3	41.1	48.1	52.6	40.0
5	35.6	40.2	48.2	50.9	41.3
6	36.4	42.3	51.9	57.3	44.2
7	35.0	41.9	47.5	49.4	40.5
8	32.8	40.3	47.8	51.2	42.4
9	35.4	40.2	49.2	53.5	41.8
10	36.1	43.7	54.6	59.2	46.6
11	34.5	39.9	49.0	51.8	42.2
12	35.2	39.3	50.3	56.3	43.4
13	37.9	44.6	51.9	55.1	45.8
14	36.5	41.2	53.2	59.0	45.4
15	33.7	37.3	45.9	53.2	38.9
16	38.3	38.7	49.2	56.9	42.0
17	36.9	41.6	47.9	50.2	41.8
18	40.1	47.0	53.9	54.6	45.6
19	37.1	43.6	50.3	--	43.1
20	37.1	43.6	51.5	54.3	43.8
21	38.3	43.4	54.7	59.3	47.3
22	35.9	42.7	47.9	51.6	41.6
23	34.3	40.9	46.7	--	40.2
24	33.2	36.7	46.7	51.2	41.2
25	38.1	46.5	57.1	61.8	48.3
26	36.3	42.8	50.4	54.6	43.3
27	38.1	46.0	52.6	54.9	46.8
28	39.8	46.1	54.8	58.5	48.2
29	39.0	44.9	53.0	57.0	45.3
30	42.9	45.6	53.0	59.0	46.5
31	37.0	44.6	53.6	56.8	46.4

APPENDIX II (continued)

Negro Subj.	Mand. 2nd Intermolar Width	Palatal Depth	Incisor Overjet	Incisor Overbite	Curve of Spee	1st Molar Relation -Right	1st Mol. Relation -Left
1	50.5 mm	22.8 mm	1.5 mm	2.6 mm	0.3 mm	1.5 mm	-1.3 mm
2	45.3	20.0	1.5	1.3	0.0	-1.5	0.0
3	48.6	22.7	1.3	2.6	0.0	-1.1	-1.6
4	47.6	20.0	2.0	2.4	0.5	-3.2	-0.5
5	45.7	17.0	3.0	2.0	1.0	-0.5	1.0
6	50.5	20.8	3.0	4.5	1.0	0.8	0.6
7	45.4	17.5	2.5	2.2	0.5	0.0	0.0
8	47.3	16.1	1.5	2.0	0.5	0.0	0.6
9	48.5	20.2	2.3	3.6	0.8	1.3	0.7
10	51.3	18.6	2.3	3.5	1.5	-2.8	-2.9
11	46.9	15.8	3.0	3.5	0.6	-1.0	-1.1
12	50.0	19.9	2.5	2.3	0.3	1.7	0.0
13	50.7	16.7	3.0	3.1	0.8	0.7	1.2
14	51.4	21.5	1.5	0.8	0.0	0.0	1.7
15	45.0	20.2	1.3	1.0	0.3	-1.2	-1.7
16	49.5	17.5	2.3	1.0	1.0	0.0	-1.8
17	47.7	21.0	2.8	2.5	1.0	0.0	0.0
18	49.5	18.9	2.5	0.5	1.0	-1.0	-1.5
19	48.6	21.6	1.0	2.2	0.8	0.0	0.0
20	49.2	17.4	3.5	3.8	0.5	-0.7	-1.2
21	53.5	19.9	2.0	2.1	0.6	0.0	0.0
22	47.8	19.2	4.5	4.2	1.8	0.0	0.0
23	44.6	20.0	1.5	1.6	0.3	-0.7	-0.7
24	46.6	17.2	1.5	1.8	0.8	-0.5	0.0
25	54.2	21.8	2.2	3.0	0.9	-2.2	-1.2
26	48.6	19.3	0.5	3.3	1.3	1.4	0.0
27	50.6	21.1	2.3	2.3	0.0	0.0	0.0
28	52.1	21.5	3.0	4.2	2.0	1.2	0.0
29	49.8	19.3	2.0	3.9	1.0	0.0	-1.8
30	52.0	21.0	2.0	1.8	0.3	1.0	0.0
31	51.6	19.9	3.5	4.4	1.0	0.0	-0.5

APPENDIX II (continued)

Negro Subj.	Canine Relation -Right	Canine Relation -Left	Max. Basal Arch Length	Mand. Basal Arch Length	Mand. Ant. Discrepancy
1	2.2 mm	0.0 mm	32.5 mm	28.6 mm	1.5 mm
2	0.0	1.3	37.0	31.9	0.0
3	0.0	0.0	35.3	34.0	0.0
4	0.9	1.9	33.6	32.6	0.5
5	1.5	3.5	35.2	32.4	1.0
6	0.9	1.7	33.2	30.2	2.1
7	0.0	1.5	34.7	33.8	0.5
8	1.6	1.5	34.8	34.6	1.5
9	0.0	0.8	37.5	32.8	2.5
10	0.0	0.0	35.2	33.4	1.0
11	1.5	1.1	37.4	33.3	3.0
12	2.8	0.0	33.5	32.0	0.5
13	1.0	0.0	35.2	33.5	2.0
14	1.4	1.1	28.6	31.5	0.0
15	-1.2	0.0	31.0	29.4	0.5
16	2.6	1.5	30.6	26.5	1.0
17	1.4	1.4	37.1	36.0	2.5
18	1.1	1.3	34.5	37.6	0.0
19	0.0	0.0	32.2	33.7	1.0
20	0.0	1.2	35.9	36.4	0.0
21	1.2	0.0	31.8	34.7	0.0
22	0.6	0.0	33.2	28.2	4.5
23	0.7	0.6	37.3	34.2	1.0
24	1.0	0.0	34.3	33.2	2.0
25	0.0	0.5	35.6	30.0	3.0
26	1.4	1.2	34.9	30.4	5.0
27	0.0	0.0	29.9	32.9	1.5
28	3.4	3.0	37.0	30.4	0.0
29	2.5	0.6	37.0	33.3	3.0
30	1.5	0.0	30.7	32.3	0.5
31	-1.4	3.9	37.7	33.7	0.0

APPENDIX III

Ratio: $\frac{\text{Midline Basal Arch Length}}{\text{Arch Length}}$

Cauc. Subj.	Maxillary Cast	Mandibular Cast	Negro Subject	Maxillary Cast	Mandibular Cast
1	0.46	0.43	1	0.42	0.37
2	0.42	0.44	2	0.46	0.43
3	0.48	0.47	3	0.42	0.45
4	0.43	0.50	4	0.40	0.44
5	0.46	0.35	5	0.43	0.45
6	0.47	0.49	6	0.40	0.41
7	0.50	0.43	7	0.41	0.47
8	0.43	0.44	8	0.44	0.56
9	0.43	0.43	9	0.42	0.42
10	0.50	0.46	10	0.40	0.44
11	0.44	0.45	11	0.43	0.44
12	0.47	0.53	12	0.39	0.42
13	0.44	0.50	13	0.41	0.43
14	0.40	0.41	14	0.34	0.42
15	0.47	0.46	15	0.39	0.41
16	0.45	0.47	16	0.37	0.35
17	0.41	0.46	17	0.41	0.44
18	0.48	0.46	18	0.37	0.44
19	0.44	0.50	19	0.38	0.43
20	0.45	0.46	20	0.40	0.47
21	0.45	0.47	21	0.36	0.42
22	0.46	0.44	22	0.41	0.39
23	0.43	0.47	23	0.42	0.43
24	0.46	0.47	24	0.41	0.43
25	0.46	0.42	25	0.40	0.39
26	0.42	0.44	26	0.42	0.41
27	0.43	0.48	27	0.34	0.42
28	0.42	0.48	28	0.42	0.39
29	0.46	0.48	29	0.41	0.42
30	0.45	0.48	30	0.37	0.43
31	0.43	0.41	31	0.42	0.43
32	0.37	0.41			
33	0.45	0.42			
34	0.45	0.44			
35	0.43	0.47			

APPENDIX III (continued)

Cauc. Subj.	Maxillary Cast	Mandibular Cast	Negro Subject	Maxillary Cast	Mandibular Cast
36	0.40	0.43			
37	0.41	0.47			
38	0.43	0.41			
39	0.40	0.50			
40	0.47	0.47			
41	0.44	0.49			
42	0.44	0.47			
43	0.43	0.45			
44	0.43	0.49			
45	0.46	0.45			
46	0.46	0.46			
47	0.48	0.48			
48	0.45	0.45			
49	0.45	0.47			
50	0.40	0.41			

APPROVAL SHEET

The thesis submitted by Dr. David A. Binotti has been read and approved by members of the Department of Oral Biology.

The final copies have been examined by the Director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated, and that the thesis is now given final approval with reference to content, form, and mechanical accuracy.

The thesis is therefore accepted in partial fulfillment of the requirements for the Degree of Master of Science.

May 16, 1969
Date

Joseph M. Goaziel
Signature of Advisor